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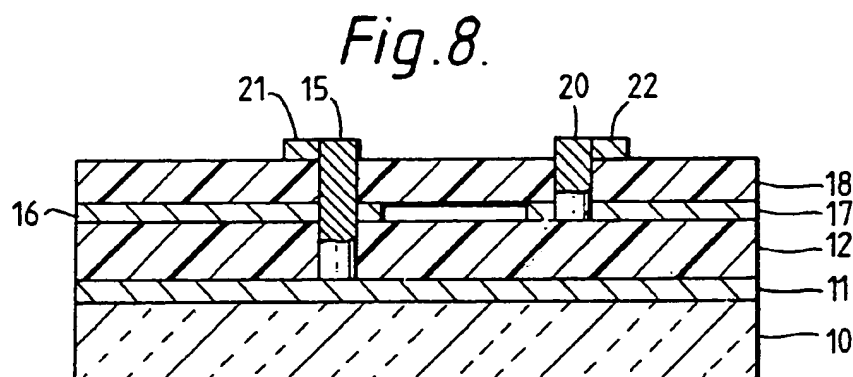
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(54) **Manufacture of printed circuit boards**

(57) A method of manufacturing a multi-layer printed circuit board is described, which provides conductive pillars 15, 20 for interconnecting the layers. Each layer is added by bonding an unsupported resin sheet 12, 18 carrying a copper layer to the previous layer. Holes are etched in the copper layer in positions where the pillars are required. The portion of the resin exposed through the holes is then removed, e.g. by chemical milling, so as to extend the holes back to the copper below. The holes are then plated, to fill them with copper forming portions of the desired pillars. The copper layer can then be masked and etched to form the required conductive tracks 16, 17, 21, 22 for the layer.



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Fig. 1.

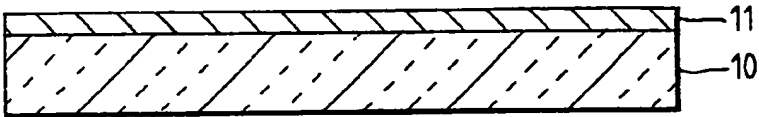


Fig. 2.

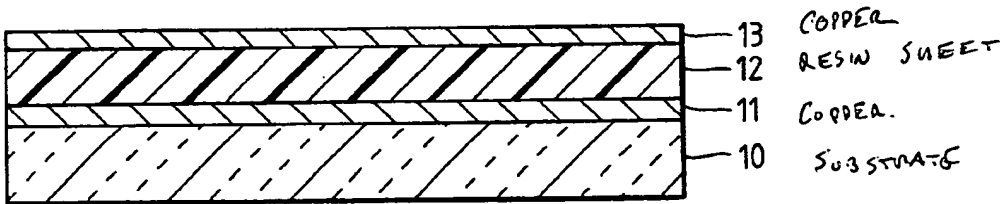


Fig. 3.

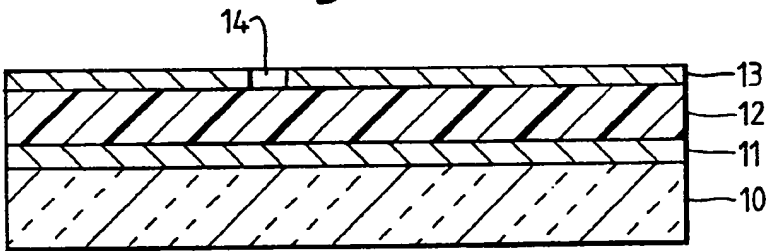
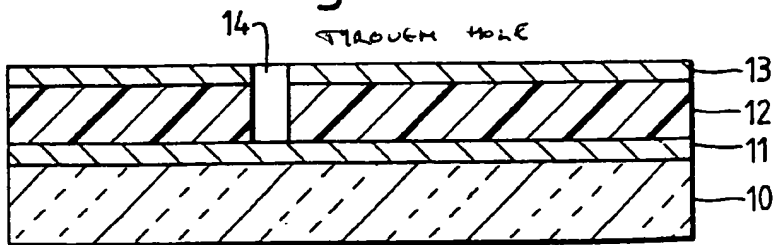


Fig. 4.



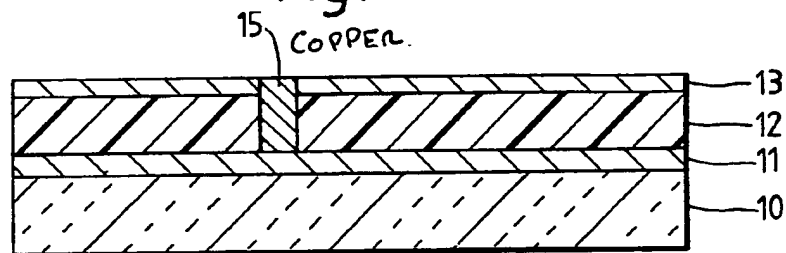
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Fig. 5.

Fig. 6.

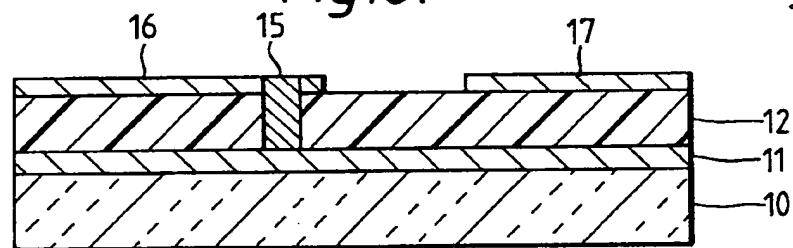
ETCHED TO FORM CIRCUIT
PATTERN.

Fig. 7.

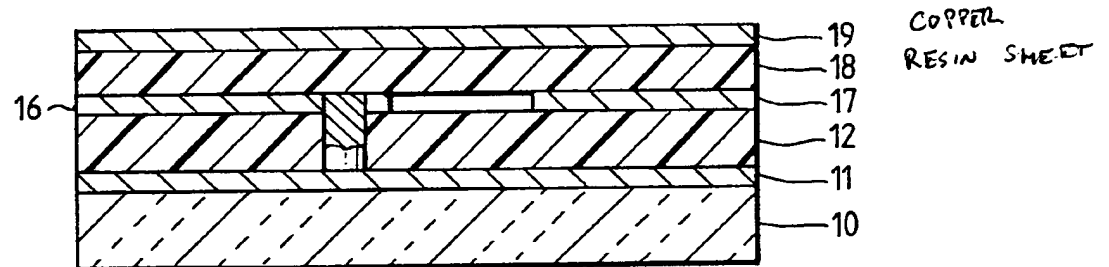
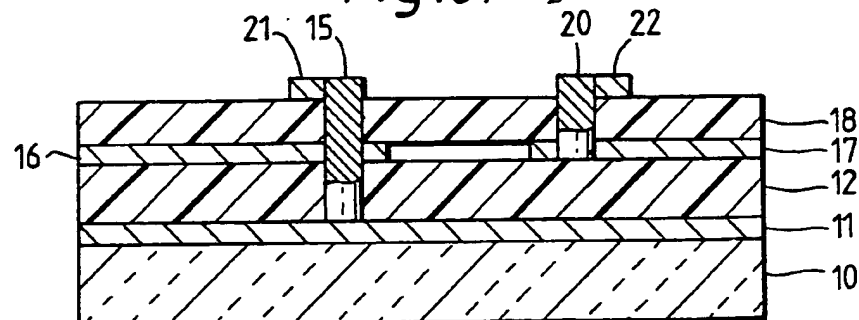


Fig. 8.

ETCHED TO FORM CIRCUIT PATTERN



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MANUFACTURE OF PRINTED CIRCUIT BOARDS

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This invention relates to the manufacture of printed circuit boards (PCBs) and in particular to multi-layer PCBs.

15 In a multi-layer PCB, it is usually required to form electrical connections between the conductive patterns in the various layers. One way of doing this is by drilling holes through the board, and then plating through these holes. Alternatively, it has been proposed to form conductive pillars within the board, extending between the
20 layers of the board so as to form electrical connections between them.

One way of forming such a pillar is by first plating up the pillar from the conductive layer below, and then applying resin in liquid form around the pillar, and
25 curing the resin so as to form a solid insulating layer surrounding the pillar. However, the use of liquid resin is inconvenient, and the object of the present invention is therefore to avoid this.

Summary of the invention

30 According to the invention, there is provided a method of manufacturing a printed circuit board comprising a plurality of layers in a stack, wherein a layer is added to the stack by the following steps:

- (a) bonding to the stack a sheet of insulating
35 material having a metal coating,
- (b) etching the metal coating to form a hole at a position corresponding to a required conductive pillar within the board,

- (c) removing the portion of the insulating material exposed through the hole, so as to extend the hole back to the layer below,
- (d) filling the hole with conductive material to form at least a portion of the required conductive pillar, and
- (e) etching the metal coating to form a required pattern of conductors.

Brief description of the drawings

One method of manufacturing a printed circuit board in accordance with the invention will now be described by way of example with reference to the accompanying drawings, which show sectional views of the PCB at successive steps of the manufacturing process.

Description of an embodiment of the invention

Referring to Figure 1, the manufacturing process starts with an insulating substrate 10, having a copper layer 11 bonded to it. In the final PCB, the copper layer 11 is intended to act as a ground plane.

Referring to Figure 2, an unsupported resin sheet 12, carrying a copper layer 13, is now bonded to the copper layer 11. In this example, the resin sheet 12 is 100 microns in thickness, and the copper layer 13 is 9 microns thick. The resin sheet may conveniently be of an FR4 type flame retardant resin.

By an unsupported resin sheet is meant one which consists only of resin, without any woven glass or other reinforcement.

Referring to Figure 3, the copper layer 13 is now masked and etched by conventional techniques to form holes 14 (only one shown) in the positions where it is desired to form the pillars in the final circuit board. In this example, the holes 14 are 50 microns in diameter.

Referring to Figure 4, the resin sheet 12 is now chemically milled through the hole 14, so as to extend the hole 14 back to the copper layer 11 below. In this example, the chemically milling is performed using a 98% sulphuric acid solution.

Referring to Figure 5, the hole 14 is now plated with copper, using a conventional electroless plating technique followed by a conventional electrolytic plating technique. The result is to fill the hole with copper 15, forming a portion of the required pillar.

Referring to Figure 6, the copper layer 13 is now masked and etched by conventional techniques so as to form the desired pattern of conductors 16,17 for this plane of the PCB. As shown in the Figure, some of these conductors 16 may make contact with the pillar 15.

The steps shown in Figures 2 to 6 can now be repeated, as many times as desired, to form a multi-layer PCB with the required number of layers.

Thus, referring to Figure 7, to form the next layer of the PCB, a further unsupported resin sheet 18 carrying a copper layer 19 is bonded to the top of the previous layer. Holes are then formed in the copper layer 19 at positions where pillars are required, and the resin sheet 18 is chemically milled to extend these holes back to the copper below. The holes are then plated so as to fill them with copper. It can be seen from Figure 8 that the copper may serve either to extend an existing pillar 15, or may form the start of a new pillar 20, which does not extend all the way down to the ground plane.

The copper layer 19 is then masked and etched to form a pattern of conductors 21,22 for this plane.

Although in the method described above chemical milling was used to remove the resin exposed through the holes in the copper layers, in other embodiments of the invention different techniques may be used for removing the resin. For example, laser drilling may be used.

Preferably, the step of bonding each successive resin sheet is performed as follows. The resin sheet is stacked on top of the existing layers of the PCB, which in turn are placed on a passive base plate. This stack is then enclosed in a plastic vacuum bag, and placed in an autoclave. The bag is evacuated by way of a hole in the base plate, and at the same time an inert gas, at high

pressure and high temperature is introduced into the
autoclave. This causes the stack to be heated, while at
the same time pressure is applied evenly to the stack from
all directions. The effect of the heating and pressure is
5 to cause the resin to flow, thereby bonding the layers
together.

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CLAIMS:-

1. A method of manufacturing a printed circuit board comprising a plurality of layers in a stack, wherein a layer is added to the stack by the following steps:
 - 5 (a) bonding to the stack a sheet of insulating material having a metal coating,
 - (b) etching the metal coating to form a hole at a position corresponding to a required conductive pillar within the board,
 - 10 (c) removing the portion of the insulating material exposed through the hole, so as to extend the hole back to the layer below,
 - (d) filling the hole with conductive material to form at least a portion of the required conductive pillar, and
 - 15 (e) etching the metal coating to form a required pattern of conductors.
2. A method according to Claim 1 wherein the sheet of insulating material comprises an unsupported resin sheet.
- 20 3. A method according to Claim 1 or 2 wherein the metal coating comprises copper.
4. A method according to any preceding claim wherein the step of filling the hole is performed by plating it with metal.
- 25 5. A method according to any preceding claim wherein the step of bonding is performed by enclosing the stack in a pressure bag, evacuating the bag, and applying pressure and heat to the outside of the bag.
6. A method of manufacturing a printed circuit board substantially as hereinbefore described with reference to
30 the accompanying drawings.
7. A printed circuit board manufactured by a method according to any preceding claim.

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